REMARKS

Specification

The examiner objected to the specification regarding inconsistencies surrounding reference numbers 34 and 38, and the specification has been amended to correct the inconsistencies.

Numerous clerical errors were also discovered in the specification and have been corrected herein.

Drawings

The examiner objected to the drawings because reference numeral 23 and 25 in FIGs. 2 and 3 did not appear to be disclosed in the specification. The specification was amended in the paragraph on page 11, lines 20-32, to disclose these reference numerals without adding new matter.

The examiner also objected to FIG. 7 because reference numeral 76 was not disclosed in the specification. A red-lined FIG. 7 is attached with reference numeral 76 deleted and new formal drawings will be submitted upon approval of the examiner.

The examiner also objected to FIGs. 5 and 7 because of missing reference numerals and red-lined FIGs. 5 and 7 are attached with changes to include the reference numerals and to correct other clerical errors. New formal drawings will be submitted upon approval of the examiner.

Applicant also discovered clerical errors in FIGs. 2, 3, 6, 10c and 11-15. These figures are also attached with red lined amendments to correct the clerical errors and new formal drawings will be submitted upon approval of the examiner.

Claims

Objections

The examiner objected to claim 31 because of a clerical error and the claim has been amended pursuant to the examiner's suggestion.

Rejected Claims

35 U.S.C. 102(b)

Claims 1, 31 and 32

The examiner rejected claims 1, 31 and 32 under 35 U.S.C. 102(b) as being anticipated by U.S. Patent No. 5,504,575 to Stafford. Claim 1 and 31 has been amended to overcome Stafford and applicant respectfully requests reconsideration of this rejection. Claim 32 depends from allowable claim 31 and is also allowable.

The disclosure of Stafford will be discussed, followed by a discussion of why amended claims 1 and 31 are allowable.

Stafford

Stafford relates to spectrometers, and more particularly, relates to spectrometers employing a spatial light modulator (SLM), such as a deformable mirror device (DMD). FIG. 3 and the supporting disclosure in Stafford were primarily relied upon by the examiner. FIG. 3 shows a SLM 90 employed in the SLM spectrometer 7, that is comprised of a linear array of small optical fibers 92 (arranged side-by-side) disposed to receive the dispersed spectrum into one end (inlet) and pass their respective discrete portions of the spectrum out at the other end (outlet) to a detector 100. Each optical fiber contains an optical shutter (or switch) 93 between the inlet and outlet

ends. The optical shutters or switches 93 are normally closed to block any radiation in their respective optical fiber 92 from the detector 100, and are selectively opened to analyze the spectrum incident on the array of fibers. After the optical shutters 93, the optical fibers are twisted and aligned to focus their respective output radiation onto the detector 100. An array of small liquid crystal devices (LCDs) may be positioned in a parallel set of openings in the array of fibers and may be employed as the optical shutters. The absorption wavelength(s) of the type of optical fiber employed must be outside the wavelengths of the spectra of interest.

The present invention discloses a shutter that is placed in the path of a millimeter beam and is either opaque or transparent to the beam. The shutter switch comprises a number of waveguides placed adjacent to one another to intercept the beam, a portion of the beam passing through each waveguide. The dimensions of each waveguide are such that transmission of the respective portion of the beam would be cut-off if the all of the waveguide walls were conductive. However, the waveguides have high impedance structures on at least two of their opposing interior walls that allow the beam at the design frequency to be transmitted through the waveguide with uniform density and minimal attenuation. At this design frequency the shutter switch to be essentially transparent to the beam. The high impedance structures can also be changed to a conductive surfaces such that all of the waveguides walls appear conductive and the waveguide takes on the characteristics of a metal rectangular waveguide. In this state transmission through each waveguide is cut-off and the shutter switch blocks transmission of the beam. The

shutter switch can change states from blocking to transparent in microseconds or less while consuming very little power.

An important difference between Stafford and the present invention is that waveguides in Stafford do not have impedance structures on their sidewalls. Instead, Stafford utilizes simple "optical fiber 92". To block transmission through the waveguide in Stafford, optical shutters or switches 93 are included that block the light. The present invention utilizes a much different arrangement that changes the impedance of the sidewalls in the waveguides to block or allow transmission of the beam through the waveguide.

To emphasize these differences, claim 1 has been amended such that the shutter switch comprises:

> a plurality of waveguides adapted to receive at least part of an electromagnetic beam, said waveguides <u>having sidewalls with alterable impedance properties, said waveguides</u> being adjacent to one another with their longitudinal axes aligned with the propagation of said beam <u>each of</u> said waveguides switchable <u>to alter the impedance properties of its sidewalls</u> to either transmit or block transmission of [their] <u>its</u> respective [portions] <u>portion</u> of said beam.

Stafford does not disclose, teach or suggest a switch with waveguides having alterable impedance properties of amended claim 1. Applicant believes that amended claim 1 is allowable over Stafford and the other references cited in the office action.

Claim 31 was rejected on similar grounds that claim 1

was rejected, and claim 31 was amended to include similar limitations regarding alterable impedance properties on the waveguide sidewalls. For the same reasons that claim 1 is allowable, claim 31 and its dependant claim 32 are also allowable.

Claims 48, 49 and 51

The examiner rejected claims 48, 49 and under 35 U.S.C. 102(b) as being anticipated by U.S. Patent No. 5,526,172 to Kanack. Regarding claim 48, the examiner essentially concluded that FIG. 25a of Kanack shows a waveguide wherein the walls can be switchable between high impedance and conductive state to control the propagation of selected modes of a beam. Applicant respectfully submits that Kanack does not show a waveguide with these features and requests reconsideration of this rejection.

In discussing FIG. 25a, Kanack notes that another use of arrays disclosed in the patent are for the interior surfaces of the walls of a waveguide. In this embodiment, movement of the 88 of the switch 80 can selective "reduce (or increase) the cross-section of the waveguide, thereby altering electrical characteristics thereof. (col. 24, lines 21-31).

Kanack does not disclose, teach or suggest a waveguide with walls switchable between high impedance and conductive states. Instead, Kanack simply relies on the properties of its swiches 80 to change the cross-section of the waveguide. There is no mention of the Kanack waveguide having impedance properties.

Applicants submit that Kanack does not disclose, teach or suggest the limitations of claim 48, and that claim 48 is allowable over Kanack. Claims 49 and 51 depend from claim 48 and are also allowable.

35 U.S.C. 103(a)

The examiner rejected Claim 50 pursuant to 35 U.S.C. 103(a) as being unpatentable over Kanack. Claims 50 depends from allowable claim 48, and is also allowable for the same reasons that claim 48 is allowable.

Allowed Subject Matter

Claims 2-30, 33-47 and 52 were objected to as being dependant upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitation of the base claim and any intervening claims. Dependant claim 2 has been amended in independent form and claims 3-30 depend from claim 2. Claim 33 has been amended in independent form and claim 34-47 depend from claim 33. Claim 52 has also been amend in independent form. All of these claims are now allowable.

All of the claims are now believed to be in proper form for allowance, and a Notice of Allowance is respectfully requested.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

Specification

Page 11, lines 20-32:

FIGs. 2 and 3 show one embodiment of the waveguide 12 used to construct the shutter switch 10. Its top and bottom walls 22 and 24 are conductive, and the inside of its sidewalls 23, 25 have high impedance structure 26. The structure 26 includes a sheet of dielectric material 28 with conductive strips 30 of uniform width on one side, the conductive strips 30 having a uniform gap 32 between adjacent strips 30. A layer of conductive material 34 is included on the side of the dielectric material 28 opposite the conductive strips 30. Vias 36 of conductive material are provided between the conductive strips 30 and the conductive layer 34, through the dielectric material 28. The conductive strips 32 are oriented longitudinally down the waveguide 12.

Page 12, line 20 to page 13, line 2:

Holes are created through the dielectric material 28 at uniform intervals, the holes continuing through the dielectric material 28 to the conductive strips 30 on the other side. The holes can be created by various methods, such as conventional wet or dry etching. They are then filled or covered with the conductive material and the uncovered side of the dielectric material is covered with a conductive material, both accomplished using sputtered vaporization plating. The holes do not need to be completely filled but the walls of the holes must be covered with the conductive material. The covered or filled holes provide conductive vias [39] 36 between the

conductive layer [38] 34 and the conductive strips [34] 30. The dimensions of the dielectric material 28, the [conductor] conductive strips 34 and the vias 39 depend on the particular design frequency for the waveguide 12.

Page 13, lines 3-21:

With the high impedance structure 26 on the waveguide's sidewalls such that the conductive strips run parallel to the waveguides longitudinal axis, the structure will present a high impedance to the E field component of a vertically polarized signal at the design frequency. As shown in FIG. 4, the gap 32 presents a capacitance 38 to the E field component that is transverse to the conductive strips. The capacitance 38 is primarily dependant upon the width of the gap 32 between the strips 30 but is also impacted by the dielectric constant of the dielectric material [26] 28. The structure 26 also presents an inductance 40 to a transverse E field, the inductance 40 being dependant primarily on the thickness of the dielectric material 28 and the diameter of the vias 36. At resonant frequency, the structure presents parallel resonant L-C circuits 42 to the vertically polarized signal and, as a result, a high impedance to a transverse E field. The E field maintains uniform power density across the waveguide, during transmission through the waveguide.

Page 13, line 28, to page 14, line 13:

The wall structure 26 also has a shorting switch [38] 39 at each of the gaps 32 that short their respective gap when closed, the details of the switches described below and shown in FIGs. 11-14. When the switches [38] 39 are open, the structure functions as described above, presenting a high impedance to a transverse E field. The

gaps 32 form the capacitive part of the resonant L-C circuits and by closing the switches [38] 39, the gaps 32 and their capacitance are shorted. The conductive strips 30 and closed switches 39 change the characteristics of the structure 26 such that it presents as continuous conductive sheet. The waveguide 12 now has conductive sidewalls along with the conductive top and bottom walls. Because the waveguides physical dimension "A" in FIG. 2 is less than the critical dimension required for the frequency, signal transmission is cut-off and blocked. In the preferred embodiment, the switches [38] 39 in all the waveguides of the shutter switch 10 are closed simultaneously, causing all the waveguides to block transmission of the signal.

Page 16, lines 10-18:

The structure 57 is manufactured using similar materials and processes described above for the embodiment shown in FIGs. [1 and 2] 2 and 3 , and the manufacturing of the shorting switches is described below. By selectively closing the switches on opposing walls of the waveguide 50, the horizontal portion, vertical portion, or both, can be cut-off. A shutter switch constructed of these waveguides can selectively block portions of a cross-polarized beam, or the entire beam.

Page 16, line 12 to page 17, line 4:

[FIGs.] FIG. 7 shows another embodiment of the waveguide 70 used to construct the shutter switch 10. The waveguide has a three-layered high impedance 71 structure its walls 72-75. In alternative embodiment the structure 71 can be on the waveguides sidewalls 72, 74 with its top and

bottom walls 73, 75 being conductive, or the structure can be on the waveguides top and bottom walls 73, 75 with its sidewalls 72, 74 being conductive. The structure 71 can have different numbers of layers, depending on the number of frequencies to be transmitted by the waveguide. The structure 71 shown has three layers and presents a high impedance to transverse E fields at three different resonant frequencies.

Page 20, line 19 to page 21, line 5:

FIGs 10a-10c illustrate how the three signals interact with layers of the new structure 71. An important characteristic of the structure's layers 104, 106, and 108 is that each appears transparent to E fields at frequencies below its design frequency, and the strips appear as a conductive surface to E fields at frequencies above its design frequency. For the highest frequency signal f1, the top layer 108 presents as high impedance resonant L-C circuits to the signal's transverse E field. The strips 110 on second layer 106 appear as a conductive layer and become a "virtual ground" for the top layer 108. <u>Signal</u> f2 is lower in frequency than f1 and, as a result, the first layer 104 is transparent to f2's E field, while the second layer [64] <u>106</u> appears as high impedance resonant L-C circuits. The [patches] <u>stips</u> 112 on the third layer appear as a conductive layer, becoming the second layer's virtual ground. Similarly, at f3 the top and second layers 108 and 106 are transparent, but the third layer 104 appears as high impedance resonant L-C circuits, with the conductive layer 114 being ground for the third layer 104.

Page 21, line 29, to page 22, line 12:

Shorting switches 116 are shown as symbols on the top layer of the structure 71 on the [top and bottom walls 73] walls 72-75, and the details of the switches are described below and shown in FIGs. 11-14. If the switches are closed on the top layer on all four of the waveguide's walls, the waveguide 70 is changed from transparent to opaque at all three frequencies. For instance, at the lowest frequency, when the first two layers of the structure appear transparent and closing the switches on the top layer shorts the gap capacitance and causes the signal to see only the conductive surface presented by the top layer's conductive strips and closed switches. The same is true for the next higher frequencies. Closing the switches causes them to see only a conductive surface, cutting off transmission.

Page 22, line 23, to page 23, line 9:

If switches 116 are included at each of the layers (not shown) then different frequencies at different polarizations can be selectively blocked. For example, f3 could be blocked in both polarizations if the switches 116 are closed on the bottom layer 82 (shown in FIG. 8) on all four walls. Only for f3 will the all the layers appear as conductive layers, cutting off transmission at f3. If the shorting switches 116 are closed on the bottom layer 82 on the top and bottom walls 73, 75 only, transmission of the horizontally polarized signal at f3 is blocked, while still transmitting the vertically polarized signals at f3. If the

switches 116 are closed on the bottom layer 82 on the sidewalls, transmission of the vertically polarized signal at f3 is blocked. By selectively closing the switches 116 at the other layers 84, 86, the different frequencies in different polarizations can be blocked.

Page 23, line 25, to page 24, line 7:

FIGs. 11, 12 and [23] 13, show one embodiment of the MEMS shorting switches [112] 132 constructed in accordance with the present invention to short the conductive strips [114] 134 in the high impedance structure [110] 130. The switches [112] 132 are fabricated using generally known micro fabrication techniques, such as masking, etching, deposition, and lift-off. FIG. 11 is a sectional view of the high impedance structure [110] 130 taken transverse to the conductive strips [114] 134. FIG. 12 is a sectional view taken long sectional lines one of the shorting switches [112] 132. Both show high impedance structure's dielectric material [116] 136, vias [118] 138 and conductive layer [120] 140.

Page 24, lines 8-17:

The switches [112] 132 are manufactured by depositing semiconductor layer [120] 140 over the conductive strips [114] 134 and over the exposed surface of the dielectric material [116] 136, the preferred semiconductor material being Si_3N_4. Stand-off isolators [122] 142 are deposited at intervals down the gap between the conductive strips [114] 134 and are preferably formed of an insulator material such

as silicon dioxide. A respective strip of metallic material [124] 144 is mounted over each of the gaps by affixing it on the top of the stand-offs [122] 142 along one of the gaps.

Page 24, lines 18-28:

In operation, each metallic strip [124] 144 has either 0 volts or voltage potential applied, with the preferred potential being 50 volts. With 0 volts applied, the strips [114] 134 remain suspended above their respective gap between the stand off isolators [122] 142 as shown in FIG. 12. The switches are in the "Off" state and the structure [110] 130 presents as a high impedance to the design frequency E field transverse to the conductive strips [114] 134. The gaps between the strips [114] 134 presents a capacitance and the vias [118] 138 present an inductance, with the structure presenting as a series of resonant L-C circuits to the transverse E field.

Page 24, line 29 to page 25, line 10:

Referring now to FIG. 13, to close the switch [112] 132 and short the gap between conductive strips [114] 134 a 50 volt potential is applied to the metallic strips [124] 144. This causes an electrostatic tension between the metallic strips [124] 144 and the respective conductive strips [114] 134 below, pulling the switch strip down such that it makes capacitive contact with the strip [114] 134 on each side of the gap. This provides a conductive bridge across the gap, shorting the gap. With all the metallic strips [124] 144 pulled to the strips [114] 134 below, the high impedance structure appears as a conductive surface to the signal's E field. This switching network consumes very

little and has a very fast closure time on the order of 30 μs.

Page 25, lines 11-19:

FIG 14 shows a high impedance structure [140] 150 with a second embodiment of the shorting switches [142] 152 that utilize varactor diode technology to short the gaps. The varactor diode is an ordinary junction diode that relies on its voltage dependent capacitance. Each varactor switch includes a N+ (highly conducting) layer [144] 154 grown or deposited in the each gap between the conductive strips [146] 156. An N- (moderately conducting) layer [148] 158 is grown on top of top of a portion of the N+ layer [144] 154.

Page 25, lines 20-30:

In fabricating the switches [142] 152, the N+ and N- layers [144] 154 and [148] 158 are etched into mesas that will provide a strip of varactor material along the length of the gaps between the conductive strips [146] 156. The switching of the varactor is controlled by a second conductive strip [150] 160 sitting on an insulator layer [152] 162 that is sandwiched between the second strip [150] 160 and each conductive strip [146] 156. The insulator layer [152] 162 provides a capacitive coupling to conductive strip [146] 156 and the ground plane. Voltage applied to the second strip [150] 160 controls the capacitance of the varactor layer and thus the shorting of the gap.

Page 26, lines 9-27:

FIG. 15 shows millimeter beam transmission system [150] 170 used in various high frequency applications such

as munitions guidance systems (e.g. seeker radar). A transmitter [152] 172 generates a millimeter signal [154] 174 that spreads as it moves from the transmitter. Most of the signal is directed toward a lens [156] 176 that collimates the signal into a beam [157] 177 with little diffraction. The collimated beam travels to a second lens 158 that focuses the beam to a receiver [160] 180. The shutter switch [162] 182 is positioned between a millimeter wave transmitter [152] 172 and receiver [160] 180 such that it intercepts the transmission beam [157] 177. When the shorting switches on the shutter switch's waveguides are open, the shutter switch [162] 182 is transparent to the beam and the signal passes from the transmitter [152] 172 to the receiver [160] 180. When the shorting switches are closed, transmission of the signal through each of the waveguides is cut-off, making the shutter switch [162] 182 opaque to the beam [157] 177 and blocking transmission from the transmitter to the receiver.

Page 26, line 28, or page 27, line 2:

As described above, when the waveguides in the shutter switch [162] 182 have the high impedance structure on the sidewalls and the top and bottom walls, the beam can have horizontal and vertical polarization and the shutter switch [162] 182 can block one or both of the polarizations. When the high impedance structure has multiple layers, the shutter switch can be transparent or block signals at multiple frequencies and at one or both polarizations.

Claims

1. (Amended) A shutter switch for an electromagnetic wave

beam, comprising:

a plurality of waveguides adapted to receive at least part of an electromagnetic beam, said waveguides having sidewalls with alterable impedance properties, said waveguides being adjacent to one another with their longitudinal axes aligned with the propagation of said beam each of said waveguides switchable to alter the impedance properties of its sidewalls to either transmit, or block transmission of [their] its respective [portions] portion of said beam.

2. (Amended) A shutter switch for an electromagnetic wave beam, comprising:

a plurality of waveguides adapted to receive at least part of an electromagnetic beam, said waveguides being adjacent to one another with their longitudinal axes aligned with the propagation of said beam, said waveguides switchable to either transmit or block transmission of their respective portions of said beam, [The shutter switch of claim 1,] wherein each of said waveguides comprises:

four wall inside surfaces comprising two opposing sidewalls and a top and bottom wall;

respective high impedance wall structures on at least two opposing walls, said wall structures presenting a high surface impedance to E fields transverse to the waveguide axis and [parallel] tangential to the said opposing wall structure, and a low impedance to E fields parallel to the waveguide axis; and

shorting [switches] arrangements on each said wall structures to short circuit their high impedances;

each of said waveguides having internal dimensions to

cut-off the transmission of its respective portion of said beam when its high impedance wall structure is short circuited to a low impedance state.

3. (Amended) The shutter switch of claim 2, wherein each said high impedance wall structure comprises:

a sheet of dielectric material having two sides;

a conductive layer on one outer side of said dielectric material;

a plurality of mutually spaced conductive strips on the other inner side of said dielectric material, said strips having gaps between adjacent said strips and being aligned parallel to the guide longitudinal axis; and

a plurality of conductive vias extending through said dielectric material between said conductive layer and said conductive strips.

5. (Amended) The shutter switch of claim 3, wherein adjacent pairs of said strips present a capacitance and said dielectric sheet presents an inductance to an electromagnetic beam with an E field transverse and tangential to said conductive strips.

6. (Amended) The shutter switch of claim 5, wherein said conductive strips and dielectric material [form] present a series connection of parallel L-C circuits, resonant at an operating frequency, to an electromagnetic beam with an E field transverse and tangential to said conductive strips.

8. (Amended) The shutter switch of claim 3, wherein said high impedance structure are provided on said waveguide's sidewalls and present a high impedance to the E field component of a [horizontally] vertically polarized guided

beam.

9. (Amended) The shutter switch of claim 3, wherein said high impedance structure are provided on said waveguide's top and bottom walls and present a high impedance to the E field component of a [vertically] horizontally polarized [signal] guided beam.

10. (Amended) The shutter switch of claim 3, wherein said high impedance structure are provided on said waveguide's sidewalls and top and bottom walls and present a high impedance to the E field component of both [horizontally] vertically and [vertically] horizontally polarized beams.

11. (Amended) The shutter switch of claim 3, wherein said shorting [switches] arrangements change said high surface impedance structure to a conductive surface by shorting said gaps between said conductive strips.

12. (Amended) The shutter switch of claim 11, wherein said shorting [switches] arrangements comprise micro electromechanical systems (MEMS) switches.

13. (Amended) The shutter switch of claim 12, wherein each of said MEMS shorting [switches] arrangements comprises a shorting strip suspended over said gap between a respective pair of said conductive strips, said [switch] gap being [closed] shorted by applying a voltage potential [to said shorting strip] to adjacent electrodes creating an electrostatic tension [between it and its respective conductive strips] that pulls said shorting strip down to said conductive strips to form a conductive bridge across said gap between said conductive strips.

14. (Amended) The shutter switch of claim 11, wherein said shorting [switches] comprise varactor diode [switches] in each of said gaps.

15. (Amended) The shutter switch of claim 14, wherein each of said varactor diode [shorting switches creates] places a [high] variable capacitance across its respective said gap [when a zero voltage applied to said diode to short said gap] such that a voltage may be applied to detune the parallel L-C circuits away from said operating frequency thus rendering the high surface impedance to a low impedance state and causing a cut-off state for said guide at said operating frequency.

16. (Amended) The shutter switch of claim 2, wherein said high impedance wall structure comprises:

a plurality of stacked high impedance layers, each presenting a high impedance surface to the E field component of a different respective electromagnetic beam operating frequency and being transparent to the E fields of lower operating frequency signals, and presenting a [conductive] low impedance surface to the E field of higher operating frequency signals; and

the bottommost said layer presenting a high impedance surface to the E field of the lowest frequency of said operating signals, and each succeeding layer presenting a high impedance surface to the E field of successively higher operating frequencies.

18. (Amended) The shutter switch of claim 16, wherein corresponding conductive strips of said high impedance layers are [vertically] aligned along the guide

longitudinal axis and said high impedance layers further comprise conductive vias through said dielectric substrates between said aligned conductive strips and said conductive layer.

20. (Amended) The shutter switch of claim 16, wherein each of said high impedance layers presents a series connection of resonant parallel L-C circuits to the E field of its respective [signal] operating frequency.

22. (Amended) The shutter switch of claim 16, wherein said high surface impedance wall structures are on said waveguide's sidewalls and present a high impedance to the E field component of said different frequency beams having [horizontal] vertical polarization.

23. (Amended) The shutter switch of claim 16, wherein said high impedance wall structures are on said waveguide's top and bottom walls and present a high impedance to the E field component of said different frequency beams having [vertical] horizontal polarization.

24. (Amended) The shutter switch of claim 16, wherein said high impedance structures are on said waveguide's sidewalls and top and bottom walls and present a high impedance to the E field component of said different frequency beams having both [horizontal and vertical] vertical and horizontal polarization.

25. (Amended) The shutter switch of claim [16] 17, [wherein said] further comprising shorting [switches] arrangements on each of said plurality of layers to change said high surface impedances [structure] to a conductive surfaces by

shorting said gaps between said conductive strips.

26. (Amended) The shutter switch of claim 25, wherein said shorting [switches] <u>arrangements</u> comprises micro electromechanical systems (MEMS) switches.

27. (Amended) The shutter switch of claim [25] <u>26</u>, wherein each of said MEMS [shorting] switches comprises a shorting strip suspended over said gap between a respective pair of said conductive strips, said switch being closed by applying a voltage potential to [said shorting strip] <u>adjacent electrodes</u> creating an electrostatic tension [between it and its respective conductive strips] that pulls said shorting strip down to said conductive strips to form a conductive bridge across said gap between said conductive strips.

28. (Amended) The shutter switch of claim 25, wherein said shorting switches comprise <u>varactor</u> diode [switches] in each of said gaps.

29. (Amended) The shutter switch of claim 28, wherein each of said varactor diode [shorting switches creates] <u>places</u> a [high] <u>variable</u> capacitance across its respective said gap [when a zero voltage applied to said diode to short said gap] <u>such that a voltage may be applied to detune the parallel L-C circuits away from said operating frequency thus rendering said high surface impedance to a low impedance state</u>.

30. (Amended) The shutter switch of claim [25] <u>28</u>, wherein said shorting [switches] <u>arrangements</u> are closed on selective layers of said high impedance structures to block

transmission one or both polarities of said beam at one or all of said different frequency signals.

31. (Amended) A millimeter beam transmission system, comprising;

an electromagnetic beam transmitter;

an electromagnetic beam receiver;

a shutter switch positioned in the path of said beam between said transmitter and receiver, said shutter switch comprising at least one waveguide positioned to receive at least part of said beam, the longitudinal axis of each [if] of said waveguides aligned with the propagation of said beam, each of said waveguide having sidewalls with alterable impedance properties [being switchable] to either transmit or block transmission of its respective portion of said beam.

33. (Amended) A millimeter beam transmission system, comprising;

an electromagnetic beam transmitter;

an electromagnetic beam receiver;

a shutter switch positioned in the path of said beam between said transmitter and receiver, said shutter switch comprising at least one waveguide positioned to receive at least part of said beam, the longitudinal axis of each if said waveguides aligned with the propagation of said beam, each of said waveguide being switchable to either transmit or block transmission of its respective portion of said beam, [The system of claim 31,] wherein each said waveguide comprises:

four wall inner surfaces comprising two opposing sidewalls and a top and bottom wall;

a high impedance wall structure on at least two

opposing walls of said waveguide, said wall structure presenting a high surface impedance to E fields transverse to the waveguide axis and [parallel] tangential to the wall structure, and a low impedance to E fields parallel to the waveguide axis; and

shorting [switches] arrangements on each said high impedance structure to change the high surface impedance of said structure to a low impedance [conductive] surface.

34. (Amended) The system of claim 33, wherein each said waveguide has inner dimensions such that the transmission of said electromagnetic beam is cut-off when said waveguide sidewalls and top and bottom walls are low impedance [conductive] surfaces.

35. (Amended) The system of claim 33, wherein each said high impedance wall structure comprises:

a sheet of dielectric material having two sides;

a conductive layer on one outer side of said dielectric material;

a plurality of mutually spaced parallel conductive strips on the other inner side of said dielectric material; and

a plurality of conductive vias extending through said dielectric material between said conductive layer and said conductive strips.

37. (Amended) The system of claim 36, wherein said conductive strips, vias and dielectric material [form] present a series connection of parallel L-C circuits to an electromagnetic wave with an E field transverse and tangential to said conductive strips.

38. (Amended) The system of claim 36, wherein said shorting [switches] arrangements change said high surface impedance structure to a [conductive] low impedance surface by shorting said gaps between said conductive strips.

39. (Amended) The system of claim 33, wherein said high impedance wall structure comprises:

a plurality of stacked high surface impedance layers, each presenting a high surface impedance to the E field component of a different respective electromagnetic beam operating frequency and being transparent to the E fields of lower frequency signals, and presenting a [conductive] low impedance surface to the E field of higher frequency signals; and

the bottommost said layer presenting a high surface impedance to the E field of the lowest frequency of said signals, and each succeeding layer presenting a high surface impedance to the E field of successively higher frequencies.

40. (Amended) The system of claim 39, wherein each said layer presents a series connection of resonant parallel L-C circuits to the E field of its respective signal operating frequency.

42. (Amended) The system of claim 39, wherein corresponding conductive strips of said layers are [vertically] aligned along longitudinal axis of said guide and said high impedance structure further comprises conductive vias through said dielectric substrates between said aligned conductive strips and said conductive layer.

43. (Amended) The system of claim 39, wherein said shorting

[switches] arrangements change said high surface impedance structure to a [conductive] low impedance surface by shorting said gaps between said conductive strips.

44. (Amended) The system of claim 33, wherein said high impedance structure are provided on said waveguide's sidewalls and present a high impedance to an a transverse and tangential E field component of [horizontally] vertically polarized beams at one or more operating frequencies.

45. (Amended) The system of claim 33, wherein said high impedance structure are provided on said waveguide's top and bottom walls such that said high impedance structure [and present] presents a high surface impedance to an E field component of a [vertically] horizontally polarized beams at one or more operating frequencies.

46. (Amended) The system of claim 33, wherein said high impedance structures are provide on said waveguide's sidewalls and top and bottom walls and present a high impedance to the E transverse and tangential field components of a [horizontally and vertically] vertically and horizontally polarized beams at one or more operating frequencies.

47. (Amended) The system of claim 46, wherein said shorting [switches] arrangements are closed on selective layers of said high impedance structures to block transmission one or both polarities of said beam at one or all of said different operating frequency signals.

52. (Amended) A method of switching an electromagnetic

beam, comprising:

transmitting said beam through one or more waveguides; and

switching the walls of said waveguides between high surface impedance and low surface impedance states to control the propagation of said beam, [The method of claim 48,] wherein said electromagnetic beam is horizontally [and] and/or vertically polarized, and has different operating frequencies, the switching of the walls between high surface impedance and [conductive] low surface impedance states controls propagation of said beam at different operating frequencies and polarizations.